DOCUMENT RESUME

ED 278 537 SE 047 697

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TITLE Upper Elementary Science Education with an Emphasis on Social Relevance.
PUB DATE May 86
NOTE 46p.; Exit Project, Indiana University, South Bend.
PUB TYPE Reports - Descriptive (141) -- Reference Materials - Bibliographies (131)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Abstracts; Educational Objectives; Elementary Education; *Elementary School Science; Learning Strategies; Literature Reviews; *Science and Society; Science Curriculum; Science Education; *Science Instruction; Social Problems; *Social Responsibility; Teaching Methods
IDENTIFIERS *Science Education Research

ABSTRACT

Designed to investigate the significance of the relationship between science education and social issues, this study presents a rationale and suggestions for incorporating elements of social responsibility into the elementary science curriculum. A review of the literature consists of annotations which focus on: (1) the importance of social issues in science education; (2) social issues and possible topics; (3) goals for social/science education; and (4) methods and strategies. A glossary is provided of terms which are referred to in the literature review. A summary section reviews social issues that can be presented in the classroom and highlights strategies for integrating relevant social issues into the curriculum. (ML)

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UPPER ELEMENTARY SCIENCE EDUCATION WITH AN EMPHASIS ON SOCIAL RELEVANCE

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A Study Directed

by

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Submitted in partial fulfillment of the requirements
for the course E591--Exit Project
Indiana University at South Bend
May, 1986

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Introduction

Science education has been emphasized in many school programs in recent years, perhaps, because educators and other public officials have finally recognized that occupations, as well as life itself will be all science and technology oriented in the near future.

Goals in science education have shifted to include societal relationships as evidenced in recent studies, which defined this new discipline in science education. (Yager) Science education should be concerned with moral issues and students should think about the consequences of their activities. (Zeidler)

The growth of science and technology in the last 100 years led to a major conference of the United Nations in Vienna. The importance of science and technology was related to national development during this conference. This led the science education community to re-think the science curricula and to include the relevance of science to society. (Chisman)

Because we have advanced so much in science and technology, the responsibilities of science teachers now should include preparing students to make decisions regarding the ethical use of the earth and its resources. (de Laeter)

Statement of the Problem

Though Science requirements may be more rigid, most science curricula include subject matter that remains unchanged. The facts of science are often taught in isolation to the real world. This is evident in many science textbooks. Concepts concerning

the nature of energy, for example, are presented disregarding the importance of energy to society. There is often an ecology unit that is separate from the rest of the material, but that is the extent of the social implications of science in many texts.

An even more significant omission in science education today is the relationship that exists between science topics and the moral decisions that constantly must be made concerning social issues.

This study is designed to investigate the significance of the relationship between science education and social issues.

Organization of the Study

This study will include a review of the literature which investigates the significance of science education as it relates to social issues. Secondly, because the term social issues implicitly suggests social awareness, the social skills necessary for this outlook will be defined and related to specific upper elementary science topics. The goals and aims of societal influences in the science curriculum will be a third consideration. The final area that this study will investigate is the social issues that should be included in the science curricula and the measures that will be needed to incorporate this discipline of social responsibility into an existing elementary science course.

Limitations of the Study

Science education is treated in a broad sense to generally include primary, secondary, and college level considerations in much of the research cited in this study. Particular attention should be paid when adapting the results of this study to lower elementary students who are limited to concrete operations regarding their capabilities.

Glossary

Bioethics -- "The systematic study of human contact in the area of the life sciences and health care, insofar as this conduct is examined in the light of moral values and principles." (Reich: introduction 19)

Decision tree -- "Type of flow chart or visual aid which summarizes the various alternatives and options available in a complex decision process. Normally drawn from left to right with lines or arrows representing possible choices linked by circles or nodes. The object is not to find optimum solutions but to represent visually a wide range of alternatives which can apply to specific procedures and decision-making. Also known as logical tree." (Page:99)

Ecology -- "The branch of science concerned with the interrelationship of organisms and their environment, the totality or pattern of relations between organisms and their environment." (Webster:382)

Environment -- "The circumstances, objects or conditions by which one is surrounded. The complex of climatic, edaphic, and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival. The aggregate of social and cultural conditions that influence the life of an individual or community." (Webster:382)

Interdisciplinary approach or method -- "Viewing a phenomenon or topic through an integration of the disciplines concerned." (Page:181)

Recombinant -- "Exhibiting genetic recombination." (Webster:965)

Scenario -- "Simulation and gaming term for the necessary background information for a game or simulation." (Page:255)

Scientific literacy -- "Not having only knowledge of the concepts, systems and processes of science, but also having the ability to learn what science one needs in order to apply it to relevant life situations." (Moyer:380)

Technology -- "Creative application of a branch of science industrial or other practical situations." (Webster:1197)

ANNOTATIONS

The Importance of Social Issues in Science Education

Chisman, Dennis G., "Science Education and National Development", Science Education 68:563-569, October, 1984.

The author discussed, in this article, The Vienna Conference on Science and Technology for Development. Countries in the United Nations prepared papers on the role of science and technology for their development. This conference believed that science and technology should serve to develop nations and to improve the human condition. Recommendations for science education were not considered, however. In November 1981, a major congress convened to address this omission. The Unesco Congress on Science and Technology Education and National Development suggested aims for science and technology education but overlooked the fact that many occupations are not science related. Chisman felt that this emphasized the need for an interaction between science education and society. He suggested that image of science should be changed to include its social relevance and scientific values.

Much of the change in the perspective of science education has come from science teachers. In the United States, for example, the National Science Teachers Association, with the support of the National Science Foundation, has initiated the Search for Excellence in Science Education program. In many countries, new curricula have evolved relating science to society.

Hurd, Paul DeHart, "Science, Technology, and Society: New Goals for Interdisciplinary Science Teaching," The Science Teacher 42:27-30, February, 1975.

A new perspective of science brought about by a changing culture is the focus of this paper by Hurd. According to the author, science is conceptualized by people in a social context, which means that science is not laboratory experiments or theories but an application of science principles for human needs. He contended that science students should be sensitive to their own values as well as the values of others. Values are also a form of knowledge. He stated that decision making is a necessary goal for science students if the societal aspects of science are to be explored. He further contended that laboratory experiments utilize the "scientific method" approach to problem solving and that this could be used to solve real life problems such as energy shortage, pollution or world food conditions. A goal that science education embodies is preparing students for the future, yet according to the author, most science curricula are written as a review of the past. The author concluded that to effectively prepare science students for the future, there should be a relationship emphasized between society and technology which requires an interdisciplinary curriculum.

Levin, Florence S. and Lindbeck, Joy S., "An Analysis of Selected Biology Textbooks for the Treatment of Controversial Issues and Biosocial Problems," Journal of Research in Science Teaching 16:199-2031, May 1979.

The purpose of Levin's and Lindbeck's study was to examine biology textbooks to determine their content relative to biosocial problems and controversial issues. The eleven variables assessed in this study were: "Darwinian evolution, disease states, drugs, environment, human genetics, human reproduction, man-his place in nature, the origin of life, the population explosion, biological effects of radiation, and race-variation in man." (p. 199) The issues were rated using both qualitative and quantitative values. Specific criteria for ratings were identified by science literature and by biology teachers. The textbooks that were rated follow.

The 1973 BSCS versions included
Biological Science: Molecules to Man
Biological Science: An Ecological Approach
Biological Science: An Inquiry into Life
The 1973 edition of Modern Biology by Otto and Towle
The 1970 edition of the Creation Research Society's
Biology: A Search for Order in Complexity.

The authors found that no one textbook covered all social issues adequately. They recommended that the teacher go beyond the textbook to supplement science courses with social issues.

Ost, David H., "Science and Cultural Values," The American Biology Teacher 38:277-280, May 1976.

Ost discussed the effects of values, society, technology and education on science. Since scientific enterprise is a motive for scientific research, it must be pointed out that science is applied directly to areas related to human values. According to the author, the course of science is patterned after our cultural needs. The author suggested that science has been considered a tool to solve problems and that it could be used in the process of values clarification. Reality Therapy developed by Glasser is an example of a systematic approach to personal reality. This skill was based on scientific problem solving. The author contended that the emphasis of science in education is analytical in nature. He suggested that patterns and relationships would be a better emphasis. He concluded that asking questions in science may encourage a cultural value system which might broaden human choices in the future.

Yager, Robert E., "Defining the Discipline of Science Education," Science Education 68:35-37, January, 1984.

Yager, through his research, has discovered that science education may be headed for some shifts in goals. He cited reports by Helgeson, Blosser, and Howe and a working paper by NSTA. In these studies, research teams have reported that inter-relationships between science and society are basic to science education. His definition of science education is a discipline concerned with the study of the interaction of science and society. This implies, then, that science education is not just limited to a classroom or laboratory. Yager pointed out that "science education is a vital link to the future of mankind." (p. 37)

Social Issues and Possible Topics

Blaga, Jeffrey J. and Cooney, Timothy M., "Teachers Need Help on Science-Related Social Issues," Phi Delta Kappan 62:400, January 1981.

The authors conducted a survey of 47 Iowa science and social studies specialists. They asked if teachers were directly teaching science-related social issues. Respondents were basically split in their answers. When asked to rate their science and social issues education, 59% rated it fair and no one rated it excellent. When asked to identify social issues that affected the U. S., the respondents chose Politics of Energy, Nuclear Power, and Alternate Energy Sources as their major concerns. Teachers agreed (95%) that they needed help to understand social issues and to develop strategies to teach students. As a result of the survey findings, the National Science Foundation funded a workshop that presented information on some social-science topics. The number of teachers that applied exceeded the positions available in the workshop, according to the authors.

Bybee, Rodger, Harms, Norris, Ward, Barbara, and Yager, Robert, "Science, Society, and Science Education," Science Education 64:377-395, July 1980.

Bybee, Harms, Ward, and Yager discussed the results of surveys. The National Science Board's Science Indicators, 1976 indicated that attitudes toward science and technology were generally favorable. The 1975 National Assessment of Educational Progress survey showed that scientific knowledge declined among American students. This survey also suggested that students believed that science and technology are responsible for problems in society. They also believed that science could contribute to the solutions of problems in the areas of food, energy, disease, pollution, and resources. It was discovered by the authors that younger age groups had less confidence in science to solve problems that adults did. The authors concluded that science education is not preparing students to be responsible in their decision making. Science students are aware of social problems, but their actions do not necessarily reflect that awareness. Surveys also indicated that they do not recognize causes of science-related societal problems. The authors felt that this indicated curriculum changes to include education about energy, pollution, food supply, disease, resource conservation, human behavior, and the exploration of controversial issues.

Dispoto, Raymond G., "Moral Valuing and Environmental Variables," Journal of Research in Science Teaching 14:273-280, July 1977.

The relationships between the development of moral values and socio-scientific issues were investigated in this study. Dispoto used Kohlberg's cognitive theory of moral development as a basis for his research. He postulated that the state of the environment was a social matter. His intent was to explore the interrelationships among moral valuing and environmental knowledge, environmental emotionality, and environmental activity. The study considered intelligence and major fields of study in college as variables. The subjects were students at Rutgers University between the ages of 18 and 21 years of age. Approximately half of the 140 subjects were males and half were females. To measure moral valuing, the Defining Issues Test (Rest et al., 1973) was used. Environmental activities, emotions, and knowledge were measured with scales developed by Maloney, Ward, and Braucht. The author concluded that moral development is related to environmental activity, environmental emotionality, and environmental knowledge. More college students were emotionally involved with the environment than knowledgeable about it and more knowledgeable about it than active with improvements. Students majoring in the sciences were found to be more knowledgeable about the environment and more environmentally active. The implications for science teaching were that teachers should stress environmental knowledge while trying to stimulate moral development using emotional moral dilemmas concerned with environmental issues.

Hofstein, Avi and Yager, Robert E., "Societal Issues as Organizers for Science Education in the '80's," School Science and Mathematics 82:539-547, November 1982.

Yager and Hofstein reviewed the science education curricula for the 1960s and compared the content and goals with those of the 1980s. They contended that science education is constantly changing. The major concern of science education is its interface with society and its relationship with technology. The goal of science in the 1960s was to produce more scientists and technologists, and the focus of science education was on knowledge and explanations. The authors maintained that the '80s focus is on the scientific knowledge that will be useful to solve societal problems and to improve living conditions. The authors considered the implications of science education based on high speed computers, new methods of transportation, fertilizer production, new materials and medicines. Yager and Hofstein also noted that science education is dependent on the government and the government is dependent on science research. The arts and other facts of human life can also be an interface with science education. The authors included topics from science programs that used social issues as a basis of study.

Kieffer, George H., "Futures Planning: Biology, Society, and Ethical Education," The Science Teacher 42:10-12, October, 1975.

The author, Kieffer, listed in this article moral and ethical issues of the new biology which included bioethics, genetics, human experimentation, behavior control, health care, population control, environmental ethics, scientific research, suicide, biological weapons and malpractice. He stated that science education should include both cognitive knowledge and moral education. The elementary grades can be a starting place to incorporate responsibility, self realization, and relationships. Kieffer suggested that a strategy might be to question values that students have with unresolved ethical issues. He stated that conclusions and teacher bias should be avoided and that solutions may take many different forms. Ethical issues in education should sensitize students to concerns related to the new biology. Students should also be informed so that they can discuss issues according to Kieffer.

Lawrenz, Frances, "Student Knowledge of Energy Issues," School Science and Mathematics 83:587-594, November, 1983.

Education in the area of energy conservation has been heavily emphasized, according to Lawrenz. In this article,the author examined a survey, which assessed the knowledge of fourth, seventh, and tenth through twelfth grade students concerning energy issues. Items to test their knowledge were taken from the National Assessment of Educational Progress, which was originally designed for adults. The questions were modified for the levels described in the survey.

The results of the survey indicated that most students were well informed about some energy topics, but they lacked information about energy resources especially in the United States. Also, future emphasis should be placed on the concept of energy along with the limitation of power production according to the author's findings.

Moyer, Wayne A., "Arguments for Maintaining the Integrity of Science Education," The American Biology Teacher 43:380-381, October 1981.

Moyer discussed the content of science classes considering Creationism versus the evolution theory. He stated that the State's duty for science education is to insure scientific literacy for future citizens. Only materials that have been published in scholarly journals, analyzed, and accepted by the science community should be included in the curriculum. Moyer presented the problems associated with teaching evolution and Creationism with a balanced treatment. Creationism, unlike scientific theories, remains unchanged and unmodified as new evidence is found. He suggested that the distinction between science and religion would be better covered in the social studies curriculum.

Sunal, Dennis W., "The Two Worlds of Energy," Social Education 44:66+, January 1980.

Dennis Sunal discussed in this article ways to incorporate the relationships that energy has in both the physical and social sense into a science class. He suggested that asking questions that allow students to guess, plan and create will initiate the lesson. He further recommended that students be shown the connection between world energy problems and their own community involvement with energy topics. The author also contended that energy education must be future oriented and that it allow students to develop decision-making skills. The United States Energy Research and Development Administration offered sequential guidelines to solve energy problems and strategies that will allow teachers to incorporate those guidelines are as follows: Gathering Information, Introducing Concepts, Developing Attitudes, Performing, Living (everyday actions that incorporate energy consciousness).

Goals for Social/Science Education

Allen, Rodney F. and LaHart, David E., "Environmental/Energy Education: An Ethical Perspective," The American Biology Teacher 41:349-353, September 1979.

After reviewing studies, the authors concluded that there have been various gestures made in response to the energy crisis. In fact, environmental education has come about as a result of the emphasis on energy conservation and other environmental issues but Allen and LaHart suggested that energy education should be focused on moral sensitivity and action. They further suggested that educators could use inquiry skills and hard knowledge of natural and social sciences to help develop a respect for persons as part of a community; a sense of equality of needs and interests; a sense of mutual interdependence; and a willingness to act for these moral commitments. The authors included nine objectives for energy education: "1. Development of a personal identity based upon a sense of community with others and recognizing one's debts to those others. 2. Development of personal awareness of one's interests, needs, feelings, and life situation within a community of others. 3. Development of moral sensitivity and empathy for others' perspectives and needs." (p. 352) 4. Development of inquiry skills and factual knowledge. 5. Development of values concepts and ethical principles. 6. Development of imagination, appropriate judgments and actions. 7. Development of citizen participation skills. 8. Development of the motivation to confront issues. 9. Development of life skills that blend morals and commitments into actions within the community."

Beisenherz, Paul C., "Putting Science and Society in Your Classroom," The American Biology Teacher 44:180-181+, March 1982.

Beisenherz suggested ways to incorporate some societal goals into biology classes. According to NSF studies made by Hurd, et al., (1980) and State and Easly (1978), textbooks and learning materials only contain limited information concerning societal issues and personal relevance. Since teachers use textbooks as a guide for their curriculum, social oriented goals should be incorporated into their courses in other ways. The author suggested the following ways: (1) Course curriculum should be designed to include personal and societal material. Some topics included environmental quality, intelligence, genetics, death, population, and race issues. (2) "Identify where society-oriented science should be placed within our school curriculum." (3) "Identify specific topics or issues to include in the course." (p. 181) (4) "Obtain a wide variety of materials that will enable students to master your instructional goals for the particular issue." (p. 181) The author suggested that libraries, ERIC materials, librarians, and colleagues can help find materials. (5) "Select and utilize a wide variety of instructional modes in the teaching of a topic." (p. 181) This may include using TV programs and simulation games. (6) Evaluation is necessary to determine whether or not these studies are relevant to students. (7) Teachers will need help to broaden their backgrounds in the areas of social issues and new instruction techniques.

Berkheimer, Glenn D. and McLeod, Richard J., "Searching for Meaning in Science Education," The Science Teacher 46:38-39, April, 1979.

Berkheimer and McLeod contended that there has been a trend in education to make learning relevant. New courses have been added to curricula to meet this demand. Those areas include environmental education, sex education, energy, and career education. The authors suggested that this has led to a science curriculum that has little structure. Because these topics are related to important social problems, they should be addressed by science education. The authors maintain that these social issues should also be examined as multidisciplinary subjects. The social problems are so complex that science can offer no simple solutions, but according to the authors, science can give students other background and skills necessary to solve problems. Berkheimer and McLeod further suggested that social problems must be resolved by using value judgments. Student should be aware of human consequences. Students should also know that science and technology are different. The authors said that science describes the world, while technology serves human needs. Students will have to know more science as well as other subjects, but science concepts will teach students to think and to resolve problems.

Bybee, Rodger W., "Science Education for an Ecological Society," The American Biology Teacher 41:154-163, March 1979.

Bybee presented findings from a survey conducted by the National Assessment of Educational Progress on students' attitudes toward social problems and science. The sample included 2500 students who were ages 9, 13 and 17 and represented the national population. They were asked if they thought pollution, energy waste and food shortages were serious problems. A majority of 9-year-olds agreed. Students were also found to make simple changes in behavior to reduce world problems. A majority of 13 and 17-year-olds were willing to support science research but 46 percent and 58 percent of the 13-year-olds and 17-year-olds thought that science was responsible for some social problems. A majority of students believed that science could solve social problems. The author contended that the survey indicates that science education should provide new information and a change in direction. The results showed that students' values are changing. To this end, Bybee developed objectives for science education based on the belief that the focus of science education is changing from an industrial emphasis to an ecological one. The following objectives were suggested: "(1) fulfill basic human needs and facilitate personal development; (2) maintain and improve the physical and human environment; (3) conserve and efficiently use natural resources; (4) develop greater community at the local, regional, national, and global levels." (p. 159) He suggested that the science goals should be interdisciplinary to encompass both scientific literacy and humanistic approaches. Textbooks already have material relating to social and environmental studies. The author also noted that teacher convention programs are offering an increasing number of environmental centered workshops. But a complete problem-centered curriculum is still needed. The following is a list that the author felt outlines the future focus of science education:

"1. The Armaments Race
2. Population Growth
3. Food Demands and Agriculture
4. Human Settlements
5. Environment and Climate
6. National Resources and Energy
7. Scientific Research
8. Technological Development
9. The Oceans
10. Outer Space
11. Nuclear Proliferation
12. Economic Stability
13. International Institutions
14. Global Interdependence" (p. 160)

DeRose, James V., Lockard, J. David, and Paldy, Lester G., "The Teacher is the Key: A Report on Three NSF Studies," The Science Teacher 46:31-37, April 1979.

In this article, authors DeRose, Lockard, and Paldy reported on three National Science Foundation studies which were conducted to determine the status of science, social studies, and mathematics education in the United States. The three studies included: "(1) a survey of school administrators, supervisors, and teachers, conducted by the Center for Educational Research and Evaluation of the Research Triangle Institute, North Carolina, of which Iris Weiss was project director; (2) a literature search by Stanley L. Helgeson, Patricia E. Blosser, and Robert W. Howe of the ERIC Center for Science, Mathematics and Environmental Education at the Ohio State University; and (3) a number of in-depth case studies conducted in a variety of school systems, directed by Robert E. Stake and Jack A. Easley of the University of Illinois-Urbana." (p. 31) The authors reported that the NSF has funded curriculum improvement projects which the survey found to be an influence in some classrooms. There were more laboratory and hands-on instruction than before the NSF curricula were used. It was discovered in the survey that the majority of the instruction in a science classroom was discussion and the major source of the information was the textbook. In a very small number of cases the teacher was actually a fellow learner. Demonstrations were observed frequently as a classroom activity. Also noted with less frequency were student reports and projects. According to the authors, most schools surveyed followed trends to make instruction measurable by adopting objectives and developing criterion testing.

The authors stated that the survey indicated that textbooks were the predominant curriculum guide in most schools, and this tended to hamper the use of inquiry skills. There was also very little utilization of community resources. The authors reported that the teacher was the most influential figure in directing the course of study as well as initiating any changes in science teaching. At the elementary level, especially, teachers were not exposed to science courses and were trained inadequately in the science areas. The authors go on to suggest that there should be an assessment of the science curriculum that is organized and it should be implemented by scientists and outstanding science educators.

Gennaro, Eugene D. and Glenn, Allen D., "Attitudes of Science and Social-Studies Teachers Toward Interdisciplinary Topics and Value Questions," School Science and Mathematics 81:451-458, October 1981.

The attitudes of science and social-studies teachers about values issues and interdisciplinary topics was the focus of a study conducted by Glen and Gennaro. They hoped that this study would help educators to relate science and social issues. A questionnaire designed to gather information regarding teachers' attitudes about their preparation and strategies for values education was sent to teachers in a large Minnesota school district. The sampling included 95 social-studies teachers and 56 science teachers. The attitudes of teachers toward interdisciplinary teaching were favorable. There were differences noted in several areas. Forty-eight to fifty percent of the teachers at the secondary and junior high levels believed that there was too much content to cover to include interdisciplinary topics. Teachers generally felt that their students had the background needed to study the extra topics. Sixty-three percent of the junior-high-school science teachers and 49 percent of the social-studies teachers believed that these studies should only be presented to the more advanced students while the senior-high levels disagreed. Science teachers (60 percent) believed that they would be able to develop material for the interdisciplinary studies, but of the social studies teachers, only 38 to 46 percent shared this confidence. The authors reported that both social studies and science teachers felt that they had strategies and were prepared to present values issues in their classrooms. They suggested that this research was limited in several ways. First they felt that the sample size was too limited. They also felt that they needed to obtain data about what actually is being done in the classrooms and how much knowledge teachers actually have about topics that overlap science and social studies. Finally the authors suggested that more research in the areas of student reactions and learning needs to be conducted.

Hiscoe, Helen B. and Ahl, Alwynelle S., "Teaching Human Reproduction--Scientific Facts and Social Issues," Journal of College Science Teaching 9:28-31, September 1979.

The authors, Hiscoe and Ahl, described a course in human reproduction which was designed to present aspects dealing with not only the scientific background, but also the technology and social issues. Their contention was that too often, citizens are asked to make decisions about such social issues without the scientific background and analysis needed to make responsible decisions. They also assumed that public policy and legislation must be made by informed citizens for the welfare of society. The course, Biological and Social Aspects of Human Reproduction, was rated highly by students. One advantage listed by students was that they were obligated to listen to opinions opposed to their own during class discussions. The authors stated that another value of this presentation was that students were responsible for offering arguments both for and against procedures related to human reproduction. Students had to continually weigh the advantages and the disadvantages of solutions to societal problems.

Jungwirth, Ehud, "Science Education and Politics," Science Education 65:253-258, July 1981.

Jungwirth, through his studies, determined that schools take an active part in developing a social competence in students especially in science. He further suggested that a social competence in teachers was necessary before this could occur. The political emphasis that many biology texts and teaching materials have was examined by the author. The texts of East German and West German cultures was compared. Environmental education in West German biology texts is treated in two ways, according to the author. One view advocated reparative steps and the other favors revolutionary changes. Environmental education in East German texts indicated that conservation measures were for the good of all unlike capitalistic systems. Using the above examples, the author illustrated that science cannot be taught in a politically neutral way. Biology teaching must include "critical observation, independent judgment, and responsible action." (p. 258) Teaching must also include the preparation of students for the future, according to the author.

Kelsh, Dennis J., "Human Values and Introductory Science," Improving College and University Teaching, 29:150, Fall 1981.

Teachers should refrain from treating social issues in science as they would any other fact or law. This was the contention of Kelsh who said that students will benefit from an open-ended treatment of social issues. This eliminates the drawing of immediate conclusions for problems. Care should be taken to make sure that the technical content of science classes is not compromised by the addition of social issues. Students should be made aware of the fact that science and technology cannot solve every problem. The author suggested that science classes are the best place to treat social issues, because they can be sympathetically examined.

McArthur, Robert P. and Smith, Wayne, L., "Ethics in Science: Recombinant Problems," Journal of Chemical Education 59:839-841, October 1982.

McArthur and Smith suggested that as science instructors, they have found teaching science and ethics both difficult. Time spent on social issues is taken away from science content. Also they found that students come away with information in limited areas only because their basic knowledge of science fundamentals is lacking. The authors contended that ethical reasoning and decision making are present in most lives, but making correct informed decisions does not necessarily come naturally. Statements of opinion on rightness and wrongness of an issue are to be avoided in science education. The goal of ethics in education should be to learn to give reasons for views and to analyze those reasons. McArthur and Smith believed that teaching ethics in science based on inserting writings on ethical positions will not adequately prepare students.

McConnell, Mary C., "Human Sciences Program: Speaking to Where Students 'Live'," The Science Teacher 45:20-22, September 1978.

Noting the importance of science taught with social issues, the author described the Human Sciences Program (HSP) of the Biological Science Curricular Study supported by the National Science Foundation in this article. The curriculum includes 15 modules with selected science topics which may have biosocial themes. Since there are so many activities in each module, students must choose the activities that they would like to do. This feature allows the teacher to develop data about the interests students have. The activities are cognitive and social in nature. McConnel discussed one particular module, Invention. The organizational questions used to develop the module included: "How does the invention work? How is it important to me? How is it important to others? What has been its past? What will be its future?" (p. 21) "Kidney Machine" was one of the 27 activities included in the Invention module. The activity included "audiovisual materials, hands-on experiences, and values-oriented dilemma discussions." (p. 21) For reactions to the "Kidney Machine" activity, the author discussed the seven schools across the country which tested this activity. McConnell found that only 13 percent of the students selected the activity and only 4 percent completed it. It was discovered that students chose the activities, "Shoes" and "Money, Money, Money." The author theorized that these activities related more closely to the lives of the students. She also concluded that some science/technology/society topics are not appropriate for children or early adolescents especially those topics dealing with abstracts. The author further concluded that more research is needed to identify topics that can be taught to students in various age groups.

Mertens, Thomas R. and Hendrix, Jon R., "Responsible Decision-making: A Tool for Developing Biological Literacy," The American Biology Teacher 44:148-152, March 1982.

Because scientists as well as the public view controversial social issues with individual value systems, the authors saw a problem on which they based this study. Their objective was to be able to combine human genetics education with bioethical decision-making skills. They developed and tested materials that dealt with: "1. A model for bioethical decision-making designed to enable students to clarify their own values rather than have their instructor's values imposed upon them. The model stresses examining alternative solutions to ethical problems and the consequences of these solutions. 2. A case study involving Down's syndrome, amniocentesis, and abortion. 3. A case study related to phenylketonuria (PKU) and issues related to mass genetic screening. 4. A case study which treats ethical issues related to recombinant DNA." (PP. 150-151) Teachers tested these materials and found that the decision-making part of the materials increased student motivation. According to the authors, the success of this program led to the founding of the Human Genetics and Bioethics Education Laboratory. This was done by the Department of Biology and Ball State University. HGABEL is concerned with public information with respect to human genetics and bioethical decision-making. The authors concluded that biology teachers and social science teachers should collaborate to develop strategies that will instill decision-making skills in students.

Saperstein, Alvin M., "Does Good Science Teaching Contradict the Requirements of Modern Technology?" Journal of College Science Teaching 10:112, November 1980.

The author discussed the differences between a technologist's role and science teaching. Though technical education is based on science education, technologists must respond to prescribed standards, rules, and time constraints, which are in opposition to the "free spirit of science." Saperstein said that scientific technologists would fall into two categories, those who study to produce standards and those who follow the rules in spite of conflicting pressures. The author suggested that even though we may not be able to resolve this conflict, teachers should initiate discussions which may help with future role selections.

Zeidler, Dana L., "Moral Issues and Social Policy in Science Education: Closing the Literacy Gap," Science Education 68:411-419, July 1984.

Zeidler contended that science literacy is not complete unless science educators include societal considerations in the curriculum. The author cited Dewey who wrote as early as 1910 that science should be more than facts or knowledge. It should be a way of thinking or inquiring. More recently, he pointed out, science is considered an interdisciplinary subject which teaches a way of thinking. This progressive view of education requires that students relate subject matter to a meaningful experience. It follows then that students learn science by being familiar with its social applications according to Zeidler. Responsible scientific teaching should include a view of the many consequences occurring when trying to solve social problems.

Zeidler outlined ways of implementing a program that would include social awareness. One major prerequisite is to give students responsibility so they can see that their individual actions affect the group. He suggested that the use of moral dilemmas, suggested by Galbraith and Jones, may allow the students to experience this social contact. This means that the teacher must be able to motivate students to think more sensitively about the connection between science and society.

Policymaking in the classroom is another way to introduce moral and ethical issues into the classroom science format, according to Zeidler. This shows students that joint participation, deliberation, and negotiations are necessary to arrive at a collective decision.

In order to achieve science literacy, Zeidler suggested that moral and ethical issues must be included in the science curriculum. In this article, he offered several suggestions which give teachers a method to sensitize students about decision making in order to better their lives now and in the future.

Zeidler, Dana L. and Schafer, Larry E., "Identifying Mediating Factors of Moral Reasoning in Science Education," Journal of Research in Science Teaching 21:1-15, January 1984.

Zeidler and Schafer reported on a study that examined how science content knowledge, the ability to morally reason, attitudes, and past experiences tempered moral judgments concerning environmental issues. The subjects in this study were categorized in two ways. The members of one group, containing 86 subjects, were third and fourth year environmental science majors from the School of Forestry at the State University of New York. The second group of 105 subjects were non-science majors at Syracuse University. The purpose of the study was three fold. The authors wanted to "determine if environmental science majors exhibit higher levels of moral reasoning on nontechnical environmental social issues than on general social issues and if they also reason at higher moral levels on environmental problems than nonscience majors." (p. 2) Secondly, they wanted to find out to what extent environmental attitudes, knowledge and personal experiences affected moral reasoning. The third purpose of this study was to determine how and to what extent people reveal their attitudes, knowledge, and experiences as they form their judgments. The study was done in two phases. Phase One involved four posttests: (1) The Defining Issues Test which measured moral reasoning on social problems by requiring subjects to rank statements concerning social dilemmas according to their importance; (2) The Environmental Issues Test, which measured the subject's moral reasoning on specific environmental issues; (3) Test of Ecology Comprehension, which measured interrelated environmental concepts; and (4) Ecology Attitudes Inventory, which measured environmental attitudes. Phase Two was the observation of the conversations of people who were forming moral judgments to identify those factors that helped form the judgments. The findings of the study indicated that "moral reasoning is influenced by the contexts (setting) of moral dilemmas." (P. 10) The authors suggested that, in some cases, a person's stand on a certain issue is influenced by an already formulated opinion. The authors also found that there are character traits like moral indignation and ones familiarity with content that are factors in moral reasoning. They found that individuals with high moral reasoning skills were able to convince others of lower moral reasoning skill that certain issues in resolving environmental moral problems were most important. Those of higher reasoning ability were also able to defend their course of action when solving the dilemmas. As students resolve moral dilemmas in science classes, discussions may improve their moral reasoning ability if teachers encourage students with different lines of reasoning to develop one solution for a group consensus, according to the authors. The arguments that ensue will challenge students to critically examine the issues and to defend their positions. Also the authors suggested that if students use past experiences to help solve a moral dilemma, the teacher should guide them to examine the issue to make sure that those experiences apply.

Methods and Strategies

Adams, David Wallace, Cornelius, David, and Pasch, Marvin, "The House of Solomon: A Lesson in Ethical Responsibility," The Science Teacher 43:18-19, December 1976.

Adams, Cornelius, and Pasch prepared a lesson for science students which demonstrated the interrelationship of discovery, invention and society. The lesson was based on the writings of Sr. Francis Bacon. Their objectives were: "To make students aware of the continuing debate over the role of the scientist in society; To enable students to generalize from particular cases to larger contemporary issues; To require students to clarify their own values; To allow students to make decisions by discussion with their peers." (p. 18) In groups of six or eight, students are given information concerning inventions or discoveries that they, as "scientists," must decide to release or suppress to their ficticious communities. Once a decision is reached their results are reported to the class and discussion follows. The positions that the "scientists" may take are to release the discovery if it will result in good consequences regardless of possible harm, to release the discovery only if the good results outweigh any harmful consequences, or to approve release if only good results are expected. The authors suggested that two questions should be raised to students. Should scientists regulate their own profession and did group values or standards influence decision making?

Ahl, Alwynelle S. and Hiscoe, Helen B., "Using Community Resources to Teach About Science and Society," The American Biology Teacher 41:242-243, April 1979.

The authors developed a technique used in biology classes to include community resources as a way to get additional data for a term paper. They started with theme subjects based on human reproduction. Students were required to search the real world for actual situations which could be included in their projects. They were instructed to interview community members and organizations involved with their topic. The authors concluded that community involved projects should be closely supervised. They found that the students not only enjoyed their projects, but they often were pointed to careers that interested them. Students reported that they learned about their community resources and were eventually able to use this information for their reports, supplementing the library as a resource.

Barman, Charles R., "Four Values Education Approaches for Science Teaching," The American Biology Teacher 42:152-156, March 1980.

The author stated that values are necessary to make science relevant to students, but they are usually taught with a focus on the teacher's value system. According to research, Barman noted four common values education approaches which allow students to examine their own beliefs. They are moral development, values clarification, action learning and analysis. Moral developments, based on Kohlberg's studies dealing with sequential stages of moral development are moral dilemma episodes. The author suggested some moral dilemmas to be presented to the class and some questions to be discussed with classmates. Value clarification is designed to help students develop a valuing process based on hierarchical steps which include choosing, prizing, and acting. According to studies done by Sidney Simon and the author, students that utilize the values clarification techniques are better able to analyze problems thereby increasing their achievement in a high school biology class. The activity "Families and Lifestyle" presented by the author helps students clarify their views about family size. Action learning lets students act on their learning using role-playing, simulations and group discussions which carry this activity to the community outside the classroom by becoming involved in a related community activity. An ecology based activity was presented by the author. Finally, analysis was suggested by the author as a way to deal critically with a value issue. The example Barman gave was "A Definition of Death" which deals with technology and our perception of death.

Bloom, Arthur and Constan, Phyllis, "The Quality of Life for the World's Population: A Unit on Bioethics," The American Biology Teacher 38:292-294, May 1976.

Authors, Bloom and Constan, developed the bioethics unit described in this article in an effort to show students that biology and other disciplines can combine to provide experiences in decision making and values education. The unit allows students to experience through role playing a world conference in which they would be delegates. Students are given population statistics of every nation that is represented in the activity. Students are also given religions, view of population control, an article on triage, information on genetic engineering and other related articles. The "delegates" are to respond to three proposals. Discussions, followed by votes, and alternative proposals allow the students to experience their roles. The authors included three values clarification strategies that helped students make logical decisions. The strategies were "20 Things I Like To Do," "Rank Order," and "Values Continuum." Based on students' reactions to the unit, the authors felt that it was successful in presenting an interdisciplinary, values-clarifying lesson.

Bridger, James A., "The Teaching of Life-Line Ethics," The American Biology Teacher 39:242-243, April 1977.

Bridger suggested techniques that he uses to explore bioethics in the classroom. One technique is the "life-line," which not only initiates discussion, but serves to unify life into a visual diagram. A line is drawn on the board, and events such as birth and death are noted on the line. Ethical issues are then listed near the life-line. Through discussion the issues are then added to the life-line. Examples of issues that he listed were abortion, suicide, and death with dignity. The discussions that ensued usually pointed out life characteristics, according to the author. Bridger used a technique called "scenario" to follow up on interest areas that were noted in the "life-line" activity. A situation concerning an ethical decision is given. Also given are roles, factors to consider, and a decision to make. The students must research, plan a group approach, and create a scenario for classmates. The author stated that this activity allows students to get involved and to interact with classmates. The final topic that the author offered was "thumbs up/thumbs down." He read statements which students reacted to with either "thumbs up" for agreement or "thumbs down" for disagreement. He included some examples of statements in the article. One example follows: "Scientists should be regulated so that only beneficial discoveries are allowed." (p. 243) Discussions follow each statement. The author also offered additional suggestions. Appropriate audio-visual aids clarify issues. Teachers should avoid judgmental statements and they should also avoid imposing their views on students. Teachers should be sensitive to individual differences concerning their students' backgrounds.

Carter, Jack L., "The Anatomy of Controversy: Freedom and Responsibility for Teaching," Bioscience 29:480-481, August 1979.

Carter traced science education through decades beginning before the fifties, when biology and other sciences were treated as a static body of knowledge. He described the science teaching revolution during the fifties and sixties when the process of science inquiry was emphasized. The problems currently facing science education are rooted in the interface between knowledge, research, and values. Educators must now deal with the social, political, and economic aspects of new scientific discoveries. The author contended that the study of human genetics and the accompanying social issues are very important considerations. He acknowledged that teachers who may not be sufficiently prepared in the knowledge of human biology will be caught between new discoveries and a declining public understanding of those innovations. Furthermore, educators may not be properly trained in the necessary humanities and ethics required for such new topics.

Compton, C. Arthur, "Short Takes: Science in Society," The Science Teacher 50:30-33, September 1983.

Compton suggested in this article that, because of time constraints, most science teachers find it difficult to include materials that relate to social issues. A conference in 1980 at Exeter Academy recommended that ethical and social issues should be a part of a science curriculum. The director of the conference, Richard Brincherhoff, began to collect information that a science teacher might use to exemplify societal or ethical consequences of a science principle or law. The criteria that Brincherhoff used for selecting the items were that it should be short, that no preparation time should be required, the item should enhance the lesson, it should relate to students' lives, it should be thought provoking and it should lead to a choice or judgment. The author listed the areas that the collection included: the consequences of human fallibility, the economics of politics of a problem situation, the process of decision making amid conflicting information or prejudice, errors once generally acknowledged as truths, the effect of new knowledge on social problems, disagreement among experts in the same field, motives for research-economic gain, curiosity, prestige, and more, the search for a technological "fix," and popular fallacies. (p. 31) The author included some suggested topics for chemistry, physics, and biology science classes.

de Laeter, John R., Lunetta, Vincent N., and Wielert, Jan S., "Science Around the Corner," The Science Teacher 51:50-53, January 1984.

According to the authors of this article, science teachers should be informed and able to prepare students to make choices that will change the irresponsible pollution and use of the non-renewable resources of our world. Science educators should be able to give those students who intend to study the sciences a substantial background in science and to make all students into science literate citizens. The authors contended that teaching science as a simple model is incorrect. Unless the nature of science is taught along with societal issues, science education fails to grow.

The authors presented several case studies of regional environmental problems that exemplified their ideas. Some ideas the pertained to our area included the collection and testing of rain samples for PH levels; an investigation of Great Lakes water levels and beach erosion; and a look at the "safe" storage of radioactive wastes compared to the geological setting. The authors concluded that real-life issues will motivate students to further studies if the topics that they investigate are relevant to them.

Hofstein, Avi, Lunetta, Vincent N., and Yager, Robert E., "Science Education Attuned to Social Issues: Challenge for the '80s," The Science Teacher 48:12-14, December 1981.

Hofstein, Lunetta, and Yager contended in this article that science education must be concerned with society and that science must be defined by social influences. Science and society both change so rapidly that science education goals and curricula are difficult to maintain. They traced the influences that social events had on science education. For example, Sputnik I seemed to affect science education by stressing logical thinking and inquiry skills. Science of the 80s should be future oriented and connect with social issues that relate to a student's own experiences, according to the author.

The authors gave some examples of programs that are concerned with injecting social responsibilities into the science curriculum. They included units from the Unified Science and Mathematics for the Elementary School, the Health Activities Project, the Human Sciences Program, the Individualized Science Instruction System, and the Outdoor Biological Instructional Strategies programs. They suggested also that governmental studies and science topics can be related in the areas of agriculture, energy, military, and the environment. Personal areas that can be included in science curricula were family planning, transportation, nutrition, mental health, and environmental responsibilities.

Meyer, James H., "Science and Society: Enrichment Exercises in Biology," The American Biology Teacher 38:417-418, October 1976.

The author, James Meyer, discussed in this article exercizes that were designed for biology students. The project, Societal Enrichments in High School Biology, was introduced at Cedar Falls High School and included exercizes that emphasized biology's impact on society. The areas that were considered in this project were "Developments in modern genetics; Human experimentation; Human behavior control; Health care problems; Population control; Environmental issues." (p. 417) The issues were presented using informational articles and students reacted using research, class presentations, written reports, surveys, community personnel, and class discussions. The author contended that the exercizes, though inexpensive, have exposed biology students to problems that currently exit. Articles for these exercizes can be found in newspapers and magazines. The exercizes were used both as a voluntary project and a course requirement. The author suggested that the constant evaluation of projects was necessary to determine which projects were most useful.

Nalence, Eugene E., "Science-Society Mini-Courses Hit Home!" The Science Teacher 47:26-28, September 1980.

Nalence discussed several programs that attempted to integrate science and society. One program, Engineering Concepts Curriculum Project, emphasized the systems of problem solving. Another program "You and Technology" never became established. The author felt that teacher education was most important to make such programs successful. He described an approach that Marple Newtown Senior High School took. Through two summer curriculum workshops, teachers produced minicourses relating science, technology and social issues. The courses included the presentations of a problem, background information, supporting laboratory work, and consideration of solutions. Social issues were emphasized as much as technical information in the mini-courses. The author discovered that the most popular courses were those concerned with energy and environment. The minicourses could be tailored to a specific local area which made studies exciting and relevant to students. He suggested that teachers replace existing illustrations in a science course with those relating science and society. The minicourses were based on five fundamental concepts: "1. The meaning of 'system' and the measurement of its efficiency; 2. The concept of equilibrium; 3. The use of optimization and 'trade-off' in system design and problem solving; 4. The ability to distinguish facts from opinions as well as the ability to use both in making decisions; 5. The ability to draw conclusions from limited data as well as to recognize the limits of such conclusions." (p. 28)

Patrick, John J. and Remy, Richard C., Science-related Social Issues: Challenges for the Social Studies, Educational Resource Information Center, ED 253 467, September 1984, pp. 1-4.

Patrick and Remy discussed three challenges that educators face preparing responsible citizens in the present society. Citizens must be informed about social issues related to science and technology. Educators must connect fields of knowledge in the curriculum underscoring social aspects of science. Educators must also answer those who threaten science education programs. The authors contended that there has been research in students' attitudes and knowledge regarding science and social issues, but textbooks still do not reflect these new educational goals. Although the authors found no theory of knowledge connecting social studies and science, they submitted that decision making skills will draw the two studies to a common goal. They suggested three instructional methods that link social studies and science. Those methods were decision trees, role play or simulation, and television or microcomputers. Patrick and Remy identified two efforts that located good instructional practices connecting science and society. Those programs are the "Search for Excellence in Science Education" and the Teaching Science Project at Pennsylvania State.

Reed, Ronald D., "An Exercise in Research Ethics," The American Biology Teacher 46:457-459, December 1984.

According to Reed, scientists no longer think of their research without thinking of its social implications. The author conducted a biology course for the United States Air Force Academy including studies of ethical issues. He found that seminars and a practical exercise helped students experience biological ethics. The seminars, explained the author, focused on the ethical design of experimentation and the scientists' ethical conduct. Some of the topics that he included were genetic engineering, human experimentation, fraud in science, and withholding results to gain an advantage over competitors. The practice exercize demanded that students analyze research, develop an experimental premise, and testing. Groups of students were to consider themselves a private company in competition with other companies. The completed project was a proposal that included a summary of studies, experiments, conclusions and company bids. The author discovered that groups presented their background, methods, results, and conclusions, but that they could not honestly recommend that their research should continue even thought their objective was to "sell" their projects. Reed reported that this project can be amended to give any student an insight into the world of scientific competition through role playing. He said that his students gained an understanding of scientific ethics in laboratory experiments.

Steiner, Elizabeth and Hitchcock, Ruth, "Teaching Moral Criticism in the Sciences," Viewpoints in Teaching and Learning 56:63-73, Fall 1980

The authors of this paper presented an approach to moral education in science that combines and strengthens the approaches that are commonly used. Steiner and Hitchcock reviewed the curricular developments that incorporated science at all levels with moral education. It was discovered that the programs approached moral education using value clarification, value analysis, or moral reasoning. The moral criticism approach was developed and was explained in this paper. After reviewing applications of the above approaches, the authors discussed the limitations of each approach. Values clarification does not go far enough because "all positions on moral issues are not equally valid. Criticism or critical thinking is necessary," according to the authors. (p. 64) Value analysis goes a step further in adequate social education by considering positions on moral issues unequally valid, but ethical standards are not approached as in the moral reasoning strategy. The authors suggested that moral reasoning according to Kohlberg relies on only one ethical principle, and its relationship to facts in resolving issues is unclear. In the moral criticism approach, criticism and moral reasoning are combined to become a process of reasoning or decision making. Using relevant criteria, conclusions about the rightness or wrongness of an issue are developed about the use or application of scientific knowledge. When scientific cases are evaluated concerning morality, moral maxims called warrants which are based on ethical standards are used. Actions then are considered as desirable to a greater or lesser degree. The authors listed topics that teachers in a 1979 workshop used to design materials utilizing the moral criticism approach. The workshop was sponsored by the National Science Foundation. Some of the categories were air pollution, solid wastes, water usage and pollution, weapons, and responsibility in scientific research.

Walker, Noojin, "Bridging the Oceans of Ignorance," School Science and Mathematics 81:153-158, February 1981.

Walker noted that there are numerous opportunities for the exploration of interdisciplinary relationships in the physical sciences. The laws, principles, and observations in science can be compared to phenomena in the disciplines of the social, economic, political, and artistic worlds. He suggested that science instruction can close the gaps between the literacy of the science world and the illiteracy of its interactions with the social world. One example Walker used to illustrate his contentions was that of the physics of optics. Images of light can be reflected, manipulated, and distorted. Light can be compared to man in his social and psychological context. Another comparison was that of Mendeleef's periodic table of elements and a piano keyboard. The periods are similar to octaves. Walker suggested that physical science could be connected to many other disciplines.

Zipko, Stephen J., "Interdisciplinary Research Reports on Bioethical Controversies," The American Biology Teacher 45:47-48, January 1983.

The author used research reports to help junior-high students examine bioethical issues. Zipko contended that teachers find it difficult, because of time constraints, to include societal considerations in their biology classes. Research reports can offer students a variety of issues in the alloted class time. The author used research reports as an end-of-year project. They required students to analyze controversy; consider the past, present and future of issues; and they helped develop research skills. The author emphasized concise reporting similar to the format of "news magazines." The reports should include an introduction, a body which is divided into sub-sections, a conclusion designed to help students form opinions and references which should include periodicals. The author claimed that bioethical research reports help students recognize that solutions to problems can often create new problems. The reports can also help students solve local problems with what they have learned. They also help students to recognize that information can be interpreted by different individuals in different ways. Students may also gain a sense of responsibility for the environment while realizing that science cannot solve every problem.

Summary

Society is directly involved in science education. As the population increases, so does society's dependence on science and technology to aid in eliminating the problems created like pollution and scarce energy supplies. (Ost) Science is also considered in a social context because of society's reliance on scientific advances that can potentially improve the quality of life. (Hurd) The massive amounts of developments including automobiles, nuclear energy, synthetic materials, electronic discoveries and the computer industry has rushed society into a tremendous technological growth. (Chisman) These new developments have made it necessary to change the goals of science education based on concepts and theories to a science curriculum that will address society's needs, role, and expectations.

Several attempts have been made to explore science and its interface with society. The Vienna Conference on Science and Technology for Development which convened in 1979 found a need to strengthen the role of the United Nations in the field of science and technology. (Chisman) The Unesco congress of science and technology education and national development met in 1981 and forwarded aims for science education which included an understanding of the interaction between science and society. The National Science Teachers' Association has initiated a program that will bring science teachers of different societies together. The program is called Search for Excellence in Science Education. (Chisman)

Even though attempts have been launched to study the focus of science education and society, this idea is relatively new. Science has recently been redefined as a discipline that investigates the impact that society has on science, and, conversely, the impact that science has on society. (Yager:1984)

There are a vast variety of social issues that can and should be presented in the classroom. Issues related to energy, though, are among the most commonly found in the curricula. The Federal Department of Energy is funding energy education. (Lawrenz) The National Science Teacher's Association developed the Project for an Energy Enriched Curriculum. (Lawrenz) Many texts include an array of energy topics. According to research, students are generally ill informed about many energy issues because of this influx of information. (Lawrenz) The areas that were indicated for future emphasis included the knowledge of energy resources in the United States, the basic concepts of the nature of energy and the considerations necessary for practical power production. (Lawrenz)

The environment is another social issue that can be presented to students using a variety of topics. Studies indicated that environmental education can be effectively carried out as responsible activity if students have the knowledge of the environmental issues. (Dispoto) Another aspect related to the concern that students will show for their environment is their level of moral development. (Dispoto) Moral and ethical issues related to the environment can also be part of the science curriculum including obligations to the unborn and ecological issues. (Kieffer)

Studies show that students' understanding of some social issues is limited, and curriculum changes need to occur. (Bybee:1980) Educators believed that the most important science-related social issues were alternate energy sources, the politics of energy, nuclear power, soil conservation, pesticides, politics of food, bioethics, air pollution standards, nitrates and nitrites, and genetic counseling. (Blaga)

It has been suggested that science can be organized around social issues which can make science more relevant to students that are affected by those issues. One example of a curriculum using social issues as a central focus is the Unified Science and Mathematics for the Elementary School. (Hofstein:1982) Some of the topics found in the curriculum are "Consumer Research," "Bicycle Transportation," and "Mass Communications." (Hofstein:1982)

The underlying goal of science education is to prepare citizens for life in our world. This is why societal influences play such an important role in the curriculum. Recognizing that many social problems arise from the loss of a sense of community is a step in the right direction. (Bybee:1979) Emphasizing our interdependence can be approached in the classroom by dealing with human relations. Listening to one another and considering other points of view are implicit in this consideration. Research suggested, especially in junior high school science, that socialization can be an important educational objective. (DeRose)

Studying personal relationships can lead to the realization that actions or decisions relating to social problems have multiple consequences. (Zeidler:1984) Students should be helped to see that social problems in science are very complex and have no easy solutions. (Berkheimer) Curriculum goals for students should include not only an understanding of science, but also an awareness of the complex effects of technology on individuals and society. (McConnell) "Our students are going to be making complex and difficult decisions. In the future, we must maintain a balance between the use of the environment and resources and other societal needs such as productivity, security, and employment." (Bybee:1979, p. 159)

Research suggested that it is not only important to emphasize science content, but also to develop positive attitudes and a sense of commitment to science-oriented social issues. (Zeidler:1984) It is necessary to use relevant personal experiences with moral issues. (Zeidler:1984) "Great care must be taken to consider students' developmental characteristics, needs, and interests." (McConnell) Another goal of science education should be to help students make their studies a personal experience. Decision-making strategies and value judgments can accomplish this goal. Considering trade-offs, benefits, side effects, and human consequences can help students see that resolving problems works better than trying to find solutions. (Berkheimer) Values education is necessary when considering uses of technology in our society. (Berkheimer)

Science programs related to social issues should be interdisciplinary for many reasons. Since science related social problems

are so complex and interrelated, they may not be solved by using only science techniques. (Bybee:1979) It has been suggested that teachers in the social sciences who are often educated in decision-making skills and value theory, can collaborate with science teachers to create strategies that will effectively merge science and societal issues. (Mertens) Surveys indicated that teachers are prepared to deal with interdisciplinary topics including value issues. (Gennaro)

Adding social issues to the science curriculum will likely improve the relevance of science education, but careful consideration must be paid to the methods and strategies that are employed to make sure that the insertion of social issues will be "real" to students. One way to allow students to experience science is to show them the connections that science has with other areas of the curriculum including social studies, economics, art, music, and literature. (Walker) (Yager:1984) Relating life's experiences to science and social issues can also make science relevant. This can be done by using a life-line, placing on it important events and issues associated with them. (Bridger)

Values clarification can offer many strategies that will not only make learning relevant but will also initiate self-awareness. A suggested values strategy called "Families and Lifestyle" has students respond to questions dealing with population. Charting responses helps students visualize their own values. (Barman:1980) Other methods that can be used are "20 Things I Like to Do," "Rank Order" which has students rank the importance of some social issues, and "Values Continuum" which has students

place themselves on a continuum between two opposing views of a social issue. (Bloom)

The most valuable strategies will have students make choices or judgments. (Compton) Decision-making which is another form of values clarification can offer a wide variety of strategies. "Thumbs up/thumbs down" is a strategy that has students indicate agreement or disagreement on an issue statement using the thumbs up or down gesture. (Bridger) Decision trees are also helpful. (Patrick)

Role playing is a strategy that allows students to experience and investigate situations involving science and social issues by actually pretending to function in a particular setting. (Adams) It allows the student to "Organize subject matter and involve cognitive operations in ways which can help learners apply the perspectives of both the social studies and science in studying complex social issues." (Patrick, p. 4)

Community resources can help integrate relevant social issues into the science curriculum. Projects that demand that students investigate community agencies can be effective. (Ahl:1979) Also case studies of real issues that are affecting a student's life in the community can get students to actually become involved in community processes. (de Laeter) (Barman:1980)

There are some additional strategies which can effectively incorporate social issues into the science program. Reports on bioethics topics, using current periodicals are especially effective for junior-high school students. (Zipko) Television can

also be useful to dramatize issues and microcomputers can be used in dynamic ways for decision-making problems. (Patrick)

A final consideration when incorporating social issues into an existing science program is time. An already crowded curriculum can still include social issues by using "Short-takes," an injection of short social thoughts or questions (Compton) or "mini-courses," which are short concise lessons. (Nalence)

Conclusions

Changes to include social issues in our science curricula are indicated. An investigation of science textbooks shows that some effort to include social issues and societal references has been made, but no one textbook covers societal influences adequately. (Levin) Unfortunately, social issues are so complex and changing constantly. To incorporate such a dynamic course of study is difficult without considering the critical role of the teacher. (DeRose) "The teacher will be the key person in selecting the most relevant issues for students in a given school." (Yager:1981, p. 12) Administrators and parents too share in this responsibility. (DeRose) Federal and state agencies can support efforts for training personnel and developing materials. (DeRose)

Recommendations

1. Science education for the future must be centered around social issues.
2. Lessons in science incorporating social issues must offer students experiences that they can relate to.
3. An already existing science curriculum can be injected with short social issues lessons as a temporary measure until larger scale procedures can be developed.
4. Lessons in science incorporating social issues must be consistent with the learners developmental stage.

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Reason for Interest in Topic:

In an attempt to make science a meaningful experience to students, I have noticed that educators as well as students regard science as an isolated subject. I would like to change this perception to include community responsibilities.